

# Computer and Data Processing Services

(SIC 737)

## SIGNIFICANT POINTS

- Employment is projected to grow 117 percent between 1998 and 2008, making this the fastest growing industry.
- Job opportunities will be excellent for most workers; the best prospects will be found in the professional and technical occupations, reflecting continuing demand for higher level skills to keep up with changes in technology.
- Computer systems analysts, engineers, and scientists and computer programmers comprise over 4 out of 10 employees in the industry.

### Nature of the Industry

All organizations today rely on computer and information technology to conduct business and operate more efficiently. Often, however, these establishments do not have the resources to effectively implement new technologies or satisfy their changing needs. When this happens, they turn to the computer and data processing services industry to meet their specialized needs on a contract or customer basis. Firms may enlist the services of one of almost 106,000 establishments in the computer and data processing services industry for help with a particular project or problem, such as setting up a secure Web site or ensuring Year 2000 compliance. Or, they may choose to “outsource” one or more activities, such as management of their entire data center or help desk support, to a computer and data processing services firm.

Services provided by this industry include prepackaged software; customized computer programming services and applications and systems software design; data processing, preparation, and information retrieval services, including on-line databases and Internet services; integrated systems design and development and management of databases; on-site computer facilities management; rental, leasing, and repair of computers and peripheral equipment; and a variety of specialized consulting services. Computer training contractors, however, are grouped with educational services, and establishments that manufacture and sell computer equipment are included with electronic equipment manufacturing. Telecommunications services are also classified separately.

Software and professional services offered within this industry include prepackaged software, custom programming, integrated systems design, and other specialized consulting. Prepackaged software establishments develop operating system software as well as word processing and spreadsheet packages, games and graphics packages, and Internet-related software tools such as search engines and Web browsers—the software that permits browsing, retrieval, and viewing of content from the World Wide Web. Some may install the software package on a user’s system and customize it to their specific needs. Programming service firms may be hired to code large programs or to get new systems up and running. Programming service firms also may update or reengineer existing systems. With the growth of the Internet and Intranets, which link people and computers within an orga-

nization, and the expansion of electronic commerce, some service companies specialize in developing and maintaining Web sites and corporate Intranets for client companies. These firms or consultants also provide assistance at various stages of development, from design and content to administration and site security. Integrated systems design firms develop and market new computer hardware and software systems, integrate new software into existing systems, or open systems to an entire organization. These firms design sophisticated computer networks, assist with upgrades or conversions, and engage in continual maintenance. They help clients select the right hardware and software products for a particular project, develop, install, and implement the system, and train their users. Other firms also offer consulting services throughout the entire process.

Information services include data preparation and processing services, as well as information retrieval services. Usually, information is collected from the client’s databases, processed, and passed to other online subscribers, to contracted users, or back to the client. Establishments in these sectors may provide payroll processing, credit reporting, data entry services, and optical scanning services, as well as the leasing of computer time. Establishments in these sectors also include the growing number of Internet service providers. These companies provide access to end users of the Internet who usually subscribe for a set fee.

Hardware services for computers and other data processing equipment include facilities management and operation, rental and leasing, maintenance and repair of computers and peripheral equipment. Such services usually are offered on the customer’s site, though in the case of maintenance and repair work, equipment may be taken to repair shops and replacements left for temporary use. Miscellaneous services establishments include database development firms engaged in building and maintaining databases of critical information. Miscellaneous services also include disk and diskette conversions, hardware requirements analysis, and computer consultants operating on a contract or fee basis.

### Working Conditions

Most workers in this industry work in clean, quiet offices. Those in facilities management or maintenance and repair may work in computer operations centers or repair shops. Given

the technology available today, however, more work can be done from remote locations using modems, fax machines, e-mail, and even the Internet. For example, data entry keyers, word processors, and secretaries may work from home with their home computers linked directly to computers at a data processing service firm. Though they often relocate to a customer's place of business while working on a project, programmers and consultants may actually perform work from locations off site. Even technical support personnel can tap into a customer's computer remotely in order to identify and fix problems.

About 6.8 percent of the workers in computer and data processing services firms work part time, compared to 15.9 percent of workers throughout all industries. For some professionals or technical specialists, evening or weekend work may be necessary to meet deadlines or solve problems. Professionals working for large establishments may have less freedom in planning their schedule than consultants for very small firms whose work may be more varied.

Data entry keyers and others who work at video terminals for extended periods of time may experience musculoskeletal strain, eye problems, stress, or repetitive motion illnesses, such as carpal tunnel syndrome.

## Employment

Employment in computer and data processing services grew by more than 900,000 jobs from 1988 to 1998. In 1998, there were about 1.6 million wage and salary jobs, and an additional 216,000 self-employed workers, making it one of the largest industries in the economy. Most self-employed workers are independent consultants. Since the late 1980s, employment has grown most rapidly in the computer programming services and prepackaged software segments of the industry. From 1988 to 1998, about 245,000 jobs were created in programming services and another 166,000 in prepackaged software.

While it has both large and small firms, the average establishment in this industry is relatively small; approximately 80

percent of establishments employed fewer than 10 workers. The majority of jobs, however, are found in establishments that employ 50 or more workers (chart). Many small establishments in this industry are startup firms that hope to capitalize on a market niche.

There are significantly fewer very young and older workers in computer and data processing establishments (table 1). The scarcity of very young workers is tied to the time required to acquire the educational and training requirements needed to qualify for many jobs in this industry. The lack of older workers reflects the industry's explosive growth in employment since the early 1980s. This huge increase in employment afforded thousands of opportunities to younger workers possessing the newest technological skills. Sufficient time has not passed for these workers to reach age 55 or older; this industry's workforce remains younger than most.

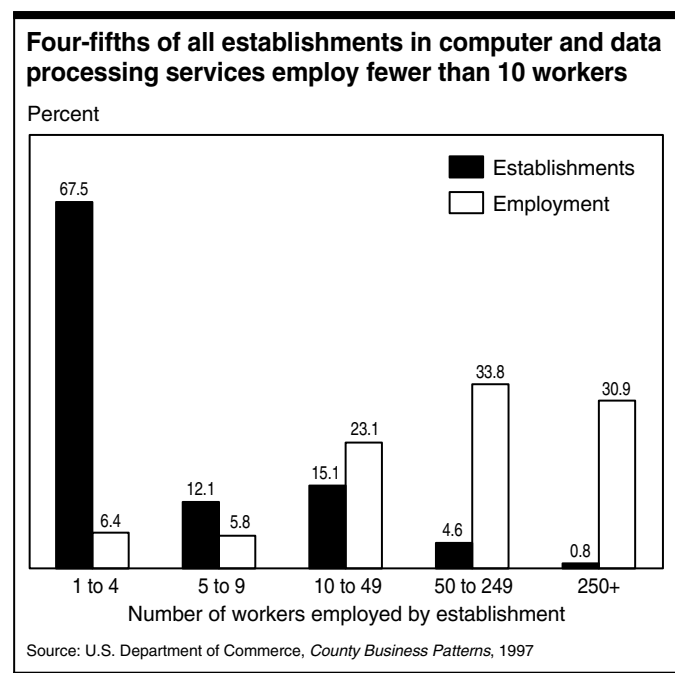
**Table 1. Percent distribution of employment in computer and data processing services by age group, 1998**

Age group	Computer and data processing services	All industries
Total .....	100.0	100.0
16-19 .....	1.6	5.4
20-24 .....	8.2	9.5
25-34 .....	35.2	23.8
35-44 .....	32.2	27.5
45-54 .....	17.0	21.0
55-64 .....	5.1	9.8
65 and older .....	0.6	2.9

## Occupations in the Industry

Providing a wide array of information services to clients requires a diverse and well-educated workforce. The majority of workers in computer and data processing services are managers; professional specialists, such as computer systems analysts, engineers, and scientists; and technicians, such as computer programmers (table 2). Together, these occupational groups accounted for 70 percent of the jobs in the industry, reflecting the emphasis on high level skills and creativity. By 2008, the employment share of professional specialty occupations is expected to be even greater, while the employment share of administrative support jobs, currently accounting for 18 percent of industry employment, is projected to fall.

*Programmers* write, test, and maintain the detailed instructions, called programs or software, that computers must follow to perform their functions. These programs tell the computer what to do, such as which information to identify and access, how to process it, and what equipment to use. Programmers write these commands by breaking down each step into a logical series, converting specifications into a language the computer understands. While many still work with traditional programming languages like COBOL, object-oriented programming languages, such as C++ and Java, computer-aided software engineering (CASE) tools, and artificial intelligence shells are now being used to create and maintain programs. These languages and tools allow portions of code to be reused in programs that require similar routines. Many programmers also customize a package to clients' specific needs or create better packages.



*Computer engineers* design and develop new software and hardware. Although programmers write and support programs in new languages, much design and development work is now the responsibility of *software engineers* or *software developers*. These professionals develop software systems for control and automation in manufacturing, business, and other areas. They research, design, and test operating system software, compilers—software that converts programs for faster processing—and network distribution software. Software engineers working in applications development analyze users' needs and design, create, and modify general computer applications software or specialized utility programs. *Hardware engineers*, on the other hand, usually design, develop, and test computer hardware and supervise production—for example, assembly of computer chips.

Other professionals involved in analyzing and solving problems include *systems analysts*, who study business, scientific, or engineering data processing problems and design new flows of information. Computers need to be connected to each other and to a control server to allow communication among users, thus enhancing use of their computing power. Systems analysts tie together hardware and software to give an organization the maximum benefit from its investment in machines, personnel, and business processes. To do this, they may design entirely new systems or add a single new software application to harness more of the computer's power. They use data modeling, structured analysis, information engineering, and other methods. Systems analysts prepare charts for programmers to follow for proper coding of machines and also perform cost-benefit analyses for management to evaluate the system. They ensure that the system performs to its specifications and test it thoroughly.

*Database administrators* determine ways to organize and store data and work with database management systems software. They set up computer databases and test and coordinate changes to them. Because they also may be responsible for design implementation and system security, database administrators often plan and coordinate security measures.

*Computer support specialists* provide technical assistance, support, and advice to customers and users. This group of occupations includes workers with a variety of titles, such as *technical support specialists*, *help desk technicians*, and *customer service representatives*. These are the troubleshooters responsible for interpreting problems and providing technical support. They answer phone calls, use automated diagnostic programs, and resolve recurrent problems.

*Other computer scientists* include a wide range of related professionals who specialize in operation, analysis, education, application, or design of a particular piece of the system. Many are involved in the design, testing, and evaluation of network systems such as LAN, WAN, Internet, and other data communications systems. Growing specialty occupations reflect an emphasis on client-server applications and end-user support; however, occupational titles shift rapidly to reflect new developments in technology. *Network or computer systems administrators*, or *network specialists*, for example, design, install, and support an organization's local area network (LAN), wide area network (WAN), network segment, or Internet system. They maintain network hardware and software, analyze problems, and monitor the network to ensure availability to system users. Administrators also may plan, coordinate, and implement network security measures. In some organizations,

*computer security specialists* are responsible for the organization's information security.

**Table 2. Employment of wage and salary workers in computer and data processing services by occupation, 1998 and projected change, 1998-2008**

(Employment in thousands)

Occupation	1998		1998-2008 Percent change
	Employment Number	Percent	
<b>All occupations .....</b>	1,599	100.0	117.1
<b>Professional specialty .....</b>	560	35.0	186.8
Systems analysts .....	141	8.8	187.6
Computer engineers .....	122	7.6	214.9
Computer support specialists .....	113	7.0	222.3
Writers and editors, including technical writers .....	21	1.3	97.0
Electrical and electronics engineers .....	21	1.3	124.6
Database administrators .....	20	1.2	238.8
Operations research analysts .....	15	1.0	55.6
<b>Administrative support .....</b>	291	18.2	62.7
Data entry keyers, except composing .....	41	2.6	57.6
Computer operators .....	37	2.3	-21.6
Secretaries .....	30	1.9	57.0
Office and administrative support supervisors and managers .....	28	1.8	91.5
General office clerks .....	25	1.6	98.8
Bookkeeping, accounting, and auditing clerks .....	22	1.4	60.4
Receptionists and information clerks .....	20	1.3	96.7
<b>Executive, managerial, and administrative .....</b>	286	17.9	94.5
General managers and top executives .....	73	4.6	91.2
Engineering, natural science, and computer and information systems managers .....	33	2.1	136.4
Financial managers .....	16	1.0	66.9
Accountants and auditors .....	16	1.0	85.1
<b>Technicians and related support .....</b>	280	17.5	79.1
Computer programmers .....	243	15.2	76.7
Engineering technicians .....	33	2.1	97.0
<b>Marketing and sales .....</b>	108	6.8	81.3
<b>Precision production, craft, and repair .....</b>	43	2.7	82.1
Data processing equipment repairers .....	23	1.5	77.3
<b>Operators, fabricators, and laborers .....</b>	25	1.6	93.5
<b>All other occupations .....</b>	6	0.4	78.0

Growth of the Internet and expansion of the World Wide Web have generated a variety of occupations relating to design, development, and maintenance of Web sites and their servers. *Web developers*, for example, are responsible for day-to-day site design and creation while *webmasters* are responsible for the technical aspects of the Web site, including performance issues such as speed of access, and for approving site content.

*Computer and information systems managers* direct the work of systems analysts, computer programmers, and other computer-related workers. They analyze the computer and

information needs of their organization and determine personnel and equipment requirements. These managers plan and coordinate activities such as the installation and upgrading of hardware and software; programming and systems design; the development of computer networks; and the implementation of Internet and Intranet sites.

Traditionally, the role of *computer operators* has been to ensure that computer systems run as efficiently as possible. Depending upon the size of the computer installation, they may work with mainframes, minicomputers, or networks of personal computers. They oversee regular operations and solve problems that surface within the system. Peripheral equipment, such as printers and tape drives, and the console of the computer itself must be correctly accessed and controlled. As errors arise, operators respond by resetting controls or terminating the run. In some establishments, they keep logs of malfunctions, suggest new equipment, or supervise and train other operators or peripheral equipment operators.

*Data entry keyers* transfer information from audio or printed forms to a computer system. Many also manipulate or edit existing data or proofread entries to an existing database. Increasingly, data are entered into computer systems at the point of origin, such as in the case of automatic teller machines and sophisticated optical character readers, which scan a document and copy the information to the computer.

*Data processing equipment repairers*, also known as *computer repairers*, maintain mainframe and personal computers, printers, and other peripheral equipment. They install new equipment for clients, do preventive maintenance, and correct emergency problems. Workers may also install operating software and peripheral equipment, checking that all components are configured to correctly function together. Repairers may work in both repair shops and customer locations. When equipment breaks down, many repairers travel to customers' workplaces or other locations to make the necessary repairs. As the amount of computer equipment increases, more installation, maintenance, and repair work will become necessary.

A number of other workers in this industry are in marketing and sales occupations. These workers are responsible for promoting and selling the products and services provided by the various sectors of this industry.

## Training and Advancement

Occupations in the computer and data processing services industry require varying levels of education. The level of education and type of training required depend on employers' needs. One factor affecting these needs is changes in technology. As demonstrated by the current demand for workers with skills related to the Internet or World Wide Web, employers often scramble to find workers capable of implementing "hot" new technologies. Another factor driving employers' needs is the time frame in which a project must be completed.

Entry level positions such as data entry keyers generally need a high school diploma. Most data entry positions are entry level and are awarded to those applicants with the greatest keyboarding speed and some business education. Computer operators may need some postsecondary education or training. Some computer operator positions may require an associate degree or even a bachelor's degree. More commonly, however, a high school diploma, previous experience with an operating system, and familiarity with the latest technologies

are the minimum requirements. Completion of vocational training also is an asset.

Computer programmers commonly hold a bachelor's degree; however, there are no universal educational requirements. Some hold a degree in computer science, mathematics, or information systems while others have taken special courses in computer programming to supplement their study in fields such as accounting, inventory control, or other areas of business. Because employers' needs are so varied, a 2-year degree or certificate may be sufficient for some positions so long as applicants possess the right technical skills.

Most computer systems analysts, engineers, and scientists, on the other hand, usually have a bachelor's or higher degree and work experience. Many hold advanced degrees in technical fields or a master's degree in business administration with a concentration in information systems and are specialists in their fields. For systems analyst, programmer-analyst, or even database administrator positions, many employers seek applicants who have a bachelor's degree in computer science, information science, or management information systems (MIS). Computer hardware engineers generally need a bachelor's degree in computer engineering or electrical engineering, whereas software engineers are more likely to hold a degree in computer science. However, computer support specialists generally need only an associate degree in a computer-related field, as well as significant hands-on experience with computers.

The size of the firm and the local demand for workers also may influence training requirements for specific jobs. Smaller firms may be willing to train informally on the job, whereas larger organizations may pay for formal training or higher education. With more formal education, employees may advance to completely different jobs within the industry. Education or training in a specialty area may provide new opportunities for the worker and allow the establishment to offer new services.

As technology becomes more sophisticated and complex, employers in all areas demand a higher level of skill and expertise. Technical or professional certification is a way employers ensure competency or quality. Many product vendors or software firms offer certification and may require it of individuals who work with their products. Many computer professionals also voluntarily obtain some type of technical or professional certification in their field.

The computer and data processing services industry offers advancement opportunities for all workers who keep up with changing technology. Beginning data entry keyers may move to project leader, and then to first-line supervisor of other keyers or to office manager. This advancement may result from work experience or from continued training and education.

Computer operators may begin on small computer installations or supervise one aspect of operations. They may move to larger systems that run a greater number of jobs and require more complex problem-solving skills. They also may advance to become operations analysts, or move into computer operations management. These employees apply available computing power to business situations, and they research and suggest upgrades or modifications to the operation of the computer system. Some operators may even become system supervisors. Because they work closely with computer operating languages and systems, computer operators may gain the

necessary experience to become programmers or customer support liaisons within their specialty. Many also seek formal education to advance to emerging occupations, such as operations analysts or network administrators.

Entry level computer programmers usually start working with an experienced programmer updating existing code, generating lines of one portion of a larger program, or writing relatively simple programs. They then advance to more difficult programming and may become project supervisors, or move into higher management positions within the organization. Many programmers who work closely with systems analysts advance to systems analyst positions.

Systems analysts may begin working with experienced analysts or may only deal with small systems or one aspect of a system. They also may move into supervisory positions as they gain further education or work experience. Systems analysts, who work with one type of system, or one aspect or application of a system, can become specialty consultants or move into management positions. Computer engineers and scientists may also advance into project leadership positions or management positions. Technical support specialists may advance by developing expertise in an area that leads to other opportunities. For example, those responsible for network support may advance into network administration or network security.

Consulting is an attractive option for experienced workers, especially programmers and systems analysts who do not wish to advance to management positions, or who would rather continue to work with hands-on applications or in a particular specialty. They may market their services on their own under contract as specialized consultants or with an organization that provides consulting services to outside clients. Many of the largest firms today have subsidiaries that offer specialized services to the host company and to outside clients.

Many experienced workers also have opportunities to move into sales positions as they gain knowledge of specific products. Data entry keyers, for example, may represent an organization in contracting with clients to ensure proper completion of a data entry project. Computer programmers who adapt prepackaged software for accounting organizations may use their specialized knowledge to sell such products to similar firms.

## Earnings

Employees in the computer and data processing services industry generally command higher earnings than the national average. This reflects the concentration of professionals and specialists who are often highly compensated for their specialized skills or expertise. Given the pace at which technology advances in this industry, earnings can be driven by demand for specific skills or experience. Workers in segments of the industry that offer only professional services have even higher average earnings because there are fewer less skilled, lower paid workers in these segments. Earnings in selected occupations in computer and data processing services appear in table 3.

As one might expect, education and experience influence earnings as well. For example, annual earnings of computer engineers ranged from less than \$37,150 for the lowest 10 percent to more than \$92,850 for the highest 10 percent in 1998. Managers usually earn more because they have been on the job longer and are more experienced than their staffs,

but their salaries too can vary by level and experience. Earnings also are affected by other factors such as size, location, and type of establishment, hours and responsibilities of the employee, and level of sales.

**Table 3. Median hourly earnings of the largest occupations in computer and data processing services, 1997**

Occupation	Computer and data processing services	All industries
General managers and top executives ...	\$43.56	\$26.05
Engineering, mathematical, and data processing managers .....	36.90	34.94
Marketing, advertising, and public relations managers .....	29.21	25.61
Computer engineers .....	27.28	28.07
Systems analysts, electronic data processing .....	24.53	23.82
Computer programmers .....	23.50	22.61
Computer support specialists .....	17.43	17.24
Secretaries, except legal and medical ....	12.15	11.00
Computer operators, except peripheral equipment .....	11.66	11.64
Data entry keyers, except composing .....	8.39	8.91

Unionization is rare in the computer and data processing services industry; less than 2 percent of all workers are union members or are covered by union contracts, compared to 15.4 percent of workers throughout private industry.

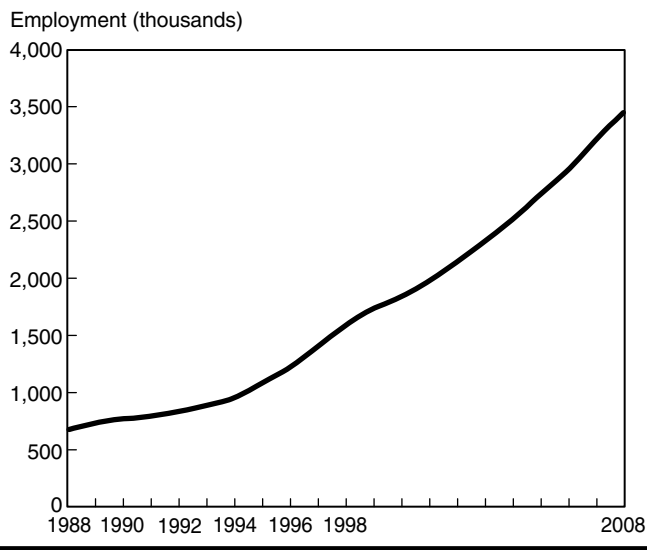
## Outlook

The computer and data processing services industry has grown dramatically in recent years and employment is expected to grow about 117 percent by the year 2008, making this the fastest growing industry in the U.S. economy (chart). Given the rate at which the computer and data processing services industry is expected to grow and the increasing complexity of technology available, job opportunities will be excellent for most workers in this industry. The best job opportunities will be created in the professional and technical occupations, reflecting their rapid growth and continuing demand for higher level skills to keep up with changes in technology.

An increasing reliance on information technology and falling prices of computers and related hardware mean that individuals and organizations will continue to turn to computer and data processing service firms to maximize the return on their investments in equipment and to fulfill their growing computing needs. Such needs include the expansion of electronic commerce, an increased reliance on the Internet, faster and more efficient internal and external communication, and the development of new technologies and applications. With increasing global competition and rising costs, organizations must be able to obtain and manage the latest information in order to make business decisions.

Within the industry, projected growth varies by sector. Among the fastest growing sectors should be client-server applications, consulting and integration services, prepackaged software, and end-user support. The demand for networking

**Employment in computer and data processing services more than doubled over the 1988-98 period, and should double again over the 1998-2008 period**



and the need to integrate new technologies will drive the demand for consulting and integration. Advances in software technology and expanding Internet usage will increase the need for software support and services. Prepackaged software has historically grown very rapidly and will continue to grow as individuals and establishments try to capitalize on the latest improvements. And, as more computing power is made available to the individual user, demand for support services should spur growth in areas such as help-desk outsourcing.

New growth areas will continue to arise from rapidly evolving technologies and business forces. The rate at which the Internet and in particular the World Wide Web have expanded demonstrates the potential effects of yet unknown technological developments and the tremendous room for growth. The expansion of the Internet and the proliferation of World Wide Web sites have created a demand for a wide variety of new products and related services including Internet and Web software, on-line services, Internet design services, web site development, and a range of specialized consulting. Yet the way the Internet is used is constantly changing, and so are the products, services, and personnel required to support new applications. Expanding electronic commerce, for example, has changed the way companies transact business, enabling markets to expand and an increasing array of services to be provided to customers. Demand for an even wider array of services should increase as companies continue to expand their capabilities, integrate new technologies, and develop new applications.

Given the increasingly widespread use of information technologies and overall rate of growth expected for the entire

industry, most occupations should experience very rapid growth, though some much faster than others. As firms continue to install sophisticated computer networks, set up Internet and Intranet sites, and engage in electronic commerce, the most rapid growth will occur among computer systems analysts, engineers, and scientists. Rapid growth is also expected among electrical and electronics engineers and computer and information systems managers. Employment of data processing equipment repairers also will grow rapidly due to increasing dependence of business and residential customers on computers and sophisticated office machines.

Employment of programmers should grow faster than the average for all occupations, but more slowly than other occupations, as the proportion of programmers decreases in relation to other types of computer professionals. Employment of administrative support occupations, including data entry keyers, is also expected to grow more slowly than the rest of the industry, while employment of computer and peripheral equipment operators is expected to decline. As client-server environments and automation continue to increase productivity, automated operating packages and robotic equipment should continue to reduce the need for such workers.

### Sources of Additional Information

Information regarding certification of computer professionals is available from:

- Institute for Certification of Computing Professionals (ICCP), 2200 E. Devon Ave., Suite 268, Des Plaines, IL 60018. Internet: <http://www.iccp.org>

Further information about computer careers is available from:

- Association for Computing Machinery (ACM), 1515 Broadway, New York, NY 10036. Internet: <http://www.acm.org>
- Institute of Electrical and Electronics Engineers—United States of America, 1828 L St. NW., Suite 1202, Washington, DC 20036. Internet: <http://www.ieee.org>

Information on the following occupations can be found in the 2000-01 *Occupational Outlook Handbook*:

- Computer, automated teller, and office machine repairers
- Computer operators
- Computer programmers
- Computer systems analysts, engineers, and scientists
- Engineering, natural science, and computer and information systems managers
- Operations research analysts
- Word processors, typists, and data entry keyers